Claims

The claimed invention is:

Sub a1

1. A method for encoding K>1 sequentially presented video pictures comprising the steps of:

(a) dividing each of the K pictures into an m>1 row x n>1 column array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, and

(b) selecting an arbitrary pseudo random pattern of coding units for refreshing during each of the K pictures, each pattern selected during any given one of the K pictures including a sequence of one or more coding units of the array,

wherein the pixels of each coding unit selected for refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures.

2. The method of claim 1 wherein the coding units are macroblocks and the coding unit positions are macroblock positions.

3. The method of claim 1 wherein the coding unit positions are sequentially ordered in a row-column direction, a coding unit position at one end of one row of the array, immediately

preceding a coding unit position at the opposite end of an adjacent row, in the sequential ordering, the method further comprising the steps of:

(c) during at least one of the K pictures, selecting plural sequences of coding units of fixed length q, the first coding unit of each of the selected sequences being offset from the first coding unit of the next selected sequence by q·K coding unit positions.

4. The method of claim 3 further comprising the steps of:

(d) initializing a length counter to a first constant and a frequency counter to a second constant,

(e) during each of the K pictures:

(f) if the length counter is equal to q then:

(g) setting the length counter to the first constant,

(h) resetting the frequency counter to the second constant minus one, if the frequency counter equals K, and

(i) incrementing the frequency counter,

(j) counting a next to-be-processed coding unit in sequential order and incrementing the length counter for the next to-be-processed coding unit, and

(k) selecting the next to-be-processed coding unit for refreshing if the frequency counter is the second constant.

5. The method of claim 3 wherein q>1, q is an exact divisor of the number of coding units in each picture and q is less than the number of coding units in each picture.

6. The method of claim 5 wherein K is free of a common divisor with m·n/q, other than 1.

7. The method of claim 4 wherein the K pictures are field pictures of interlaced frames, wherein each coding unit is an interlaced field coding unit, and wherein spatially interleaved field coding units from a single given frame are refreshed during sequential pictures k, k+1 of the sequence of K pictures, the method further comprising the step of, performing steps (e)-(k) for each field of each frame, and for each field:

(l) if the last coding unit at the last field of the frame is reached, setting a frame counter equal to the frequency counter, and

(m) if the last coding unit of a field other than the last field of the frame is reached, setting the frequency counter equal to the frame counter.

8. The method of claim 1 wherein each of the K pictures is a field picture of an interlaced frame, each coding unit is an interlaced field coding unit and wherein spatially interleaved field coding units from a single given frame are refreshed during sequential pictures k, k+1 of the sequence of K pictures.

9. The method of claim 1 wherein the pattern of sequences is decorrelated from picture to picture.

10. The method of claim 9 wherein the starting and ending coding units of each sequence are located in coding unit positions of different columns of the array over successive ones of the K pictures.

11. The method of claim 9 wherein each sequence starts at a coding unit position which is offset from the leftmost coding unit position of the row of the array containing the beginning of the sequence by one or more coding unit positions, ends at a coding unit position which is offset from the rightmost coding unit position of the row of the array containing the end of the sequence by one or more coding unit positions, or both.

12. An apparatus for encoding K>1 video frames comprising:

(a) a source for supplying a sequence of K>1 frames, each of which is divided into an m>1 row x n>1 column array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, and

(b) an inter/intra decision circuit for selecting an arbitrary, pseudo random pattern of coding units for refreshing during each of the K pictures, each pattern selected during any given one of the K pictures including a sequence of one or more coding units of the array,

wherein the pixels of each coding unit selected for refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures.

13. The apparatus of claim 12 wherein the coding units are macroblocks and the coding unit positions are macroblock positions.

14. The apparatus of claim 12 wherein the coding unit positions are sequentially ordered in a row-column direction, a coding unit position at one end of one row of the array, immediately preceding a coding unit position at the opposite end of an adjacent row, in the sequential ordering, wherein the inter/intra decision circuit is also for, during at least one of the K frames, selecting plural sequences of coding units of fixed length q, the first coding unit of each of the selected sequences being spaced from the first coding unit of the next selected sequence by q·K coding unit positions.

15. The apparatus of claim 14 wherein the inter/intra decision circuit is also for:

initializing a length counter to a first constant and frequency counter to a second constant, and

during each of the K frames:

if the length counter is equal to q then:

setting the length counter to the first constant,

resetting the frequency counter to the second constant minus one, if the frequency counter equals K, and

incrementing the frequency counter,

counting a next to-be-processed coding unit in sequential order and incrementing the length counter for the next to-be-processed coding unit, and,

selecting the next to-be-processed coding unit for refreshing if the frequency counter is the second constant.

16. The apparatus of claim 14 wherein q>1, q is an exact divisor of the number of coding units in each picture and q is less than the number of coding units in a picture.

17. The apparatus of claim 16 wherein K is free of a common divisor with m·n/q, other than 1.

18. The apparatus of claim 14 wherein each of the K pictures is a field picture of an interlaced frame, each coding is an interlaced field coding unit and wherein spatially interleaved field coding units from a single given frame are refreshed during sequential pictures k, k+1 of the sequence of K pictures, wherein the inter/intra decision circuit is also for:

for each field, if the last coding unit at the last field of the frame is reached, setting a frame counter equal to the frequency counter, and if the last coding unit of a field other than the last field of the frame is reached, setting the frequency counter equal to the frame counter.

19. The apparatus of claim 12 wherein each of the K pictures is a field picture of an interlaced frame, each coding unit is an interlaced field coding unit and wherein spatially interleaved field coding units from a single given frame are refreshed during sequential pictures k, k+1 of the sequence of K pictures.

20. The apparatus of claim 12 wherein the pattern of sequences is decorrelated from picture to picture.

21. The apparatus of claim 20 wherein the starting and ending coding units of each sequence are located in coding unit positions of different columns of the array over successive ones of the K pictures.

22. The apparatus of claim 20 wherein each sequence starts at a coding unit position which is offset from the leftmost coding unit position of the row of the array containing the beginning of the sequence by one or more coding unit positions, ends at a coding unit position which is offset from the rightmost coding unit position of the row of the array containing the end of the sequence by one or more coding unit positions, or both.

23. An encoded video signal comprising a sequence of K>1 encoded frames, each of the frames being divided into an m>1 x n>1 array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, each of the K pictures including an arbitrary, pseudo random pattern of refreshed coding units, the refreshed coding units being spatially only encoded, each pattern of coding units selected for refreshing during any given one of the K pictures including a sequence of one or more coding units of the array, wherein the pixels of each coding unit selected for refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel

position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures.

24. A storage medium for storing an encoded video signal comprising a sequence of K>1 encoded frames, each of the frames being divided into an m>1 x n>1 array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, each of the K pictures including an arbitrary pseudo random pattern of refreshed coding units, the refreshed coding units being spatially only encoded, each pattern of coding units selected for refreshing during any given one of the K pictures including a sequence of one or more coding units of the array, wherein the pixels of each coding unit selected for refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures.

25. An apparatus for decoding a video signal containing a sequence of K>1 encoded frames, each of the frames being divided into an m>1 x n>1 array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, each of the K pictures including an arbitrary pseudo random pattern of refreshed coding units, the refreshed coding units being spatially only encoded, each pattern of coding units selected for refreshing during any given one of the K pictures including a sequence of one or more coding units of the array, wherein the pixels of each coding unit selected for

refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures, the apparatus comprising:

(a) a spatial decoder for spatially decoding each coding unit,

(b) a motion compensator, for adding coding units outputted from the spatial decoder, other than the coding units which were spatially only encoded, to predictions derived from reconstructed reference pictures, and

(c) a frame memory for storing the reconstructed reference pictures formed from coding units decoded by the spatial decoder and coding units decoded by the motion compensator, wherein over the K pictures, a coding unit in each coding unit position of a moving picture image is reconstructed from a coding unit which is designated for refreshing, spatially only encoded and decoded only by the spatial decoder without data from another coding unit or picture.

26. A method for decoding a video signal containing a sequence of K>1 encoded frames, each of the frames being divided into an m>1 x n>1 array of non-overlapping coding units of equal sizes, each coding unit occupying a respective coding unit position in the picture from which it was divided, each of the K pictures including an arbitrary, pseudo random pattern of refreshed coding units, the refreshed coding units being spatially only encoded, each pattern of coding units selected for refreshing during any given one of the K pictures including a sequence of one or more coding units of the array, wherein the pixels of each coding unit selected for

refreshing during a k^{th} picture occupy different pixel positions than each coding unit selected for refreshing during a preceding one of the 1^{st} to $(k-1)^{th}$ pictures of the K pictures, and wherein each pixel position of a moving picture image formed from the K pictures is selected for refreshing once over the sequence of K pictures, the method comprising:

(a) spatially decoding each coding unit,

(b) adding coding units produced in step (a), other than the coding units which were spatially only encoded, to predictions derived from reconstructed reference pictures, and

(c) forming the reconstructed reference pictures from spatially only decoded coding units, and spatially decoded coding units added to predictions, wherein over the K pictures, a coding unit in each coding unit position of a moving picture image is reconstructed from a coding unit designated for refreshing, spatially only encoded and only spatially decoded without data from another coding unit or picture.